Form ESA-B4. Summary Report for ESA-252-3

Public Report - Final

Company	Tootsie Roll Industries	**ESA Dates**	Dec 1-3, 2008
Plant		**ESA Type**	Steam
Product		**ESA Specialist**	Greg Wheeler

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
The plant produces candies from sugar, milk, cocoa, corn syrup, natural and artificial flavors. Primary products include Tootsie Rolls, Lollipops, and Dots. Ingredients are mixed, cooked in steam-jacketed cookers, shaped, cured or dried, packaged and shipped.

Objective of ESA:
The objective of the ESA is to model selected steam systems using the USDOE Steam Tool Suite and to use the tools to identify savings from several measures that would improve system efficiency. It is not the objective of the ESA to look at all potential plant improvement opportunities.

Focus of Assessment:
The focus of the ESA is for plant personnel to understand how the appropriate DOE tools can be effectively applied in the plant. The focus of this ESA is the steam system.

All three identical 600 hp, Cleaver-Brooks scotch marine, 4-pass boilers have feedwater economizers and turn-down ratios to 10% fire. Two boilers typically operate.. One boiler operates most weekends and for approximately 3 weeks per year. Two boilers typically operate the rest of the year because the peak daily load exceeds the capacity of one boiler.

The steam system includes:

Steam System Equipment			
Equipment	**Manufacturer**	**Model**	**Input 10^6Btu/hr**
Unit #1	Cleaver Brooks	CB 700-600	25.1
Unit #2	Cleaver Brooks	CB 700-600	25.1
Unit #3	Cleaver Brooks	CB 700-600	25.1
Total			75.3

Approach for ESA:
1. Identify and understand the target system(s) and determine priorities for opportunities to pursue.
2. Identify critical flows, temperatures, pressures, areas, and other information that will be required for the analysis.
3. Gather available data and trend logs and develop a list of data that needs to be obtained from other sources or that needs to be measured.

4. Enter this data into the steam tools and check for internal consistency, such as with metered energy use. Data will be verified and adjusted, if necessary. Team members will enter data into the steam tools program and check results for feasibility.
5. Acquire cost estimates from vendors if possible. Estimate range of improvement costs from previous plant and Qualified Specialist experience.
6. Demonstrate steam tools to interested participants.
7. Complete:
    - Steam System Scoping Tool (SSST.exe or steamtools.xls)
    - Plant Intake Questions
    - Summary Report
    - Software Tool Output
    - Evaluation

General Observations of Potential Opportunities:
We measured boiler stack gas temperatures and concentrations of excess oxygen (O2) and carbon monoxide (CO) and used the stack loss tab in SSAT to calculate combustion efficiency. We further used 1% shell losses to estimate boiler efficiency.

We measured pipe, tank, and boiler surface temperatures with the plant's infrared thermometer. Surfaces are generally well-insulated with temperatures approximately 125F with some minor exceptions. We used the 3E-Plus tool to calculate savings from insulating bare steam and condensate piping and adding replacing insulation on the boilers.

The primary tool used was the Steam System Assessment Tool. SSAT is a structured software-based steam system simulation model. It is designed to allow you to build approximate models of your site steam system and to predict savings achieved from the implementation of key steam system Best Practice measures.

SSAT simulates the following major equipment:

- Boiler
- Back pressure turbines
- Condensing turbine
- Deaerator
- Letdowns
- Flash vessels
- Feedwater preheat exchangers
- Steam traps

SSAT also prepares helpful schematic representations of the site steam system, estimates site environmental emissions, and calculates project energy and operating cost savings

Project opportunities that can be evaluated using SSAT include:

- Steam savings
- Use of alternative boiler fuel
- Improved boiler efficiency
- Reduction of boiler blowdown rate
- Installing blowdown flash system to produce low pressure steam
- Change of steam generation conditions
- Installing new back pressure turbine(s)
- Installing new condensing turbine

- Installing new heat recovery exchangers to preheat feedwater
- Increasing condensate recovery
- Installing condensate flash system
- Reducing steam trap losses and steam leaks
- Improving pipework insulation

We added projects to SSAT individually rather than incrementally and recorded the results to capture savings from each Energy Efficiency Measure (EEM) separately from other EEMs. The results might overestimate savings by 10-15% if all measures are implemented. The following results and recommendations represent the best information available at the time. Results from the following four (7) Energy Efficiency Measures (EEM) from SSAT are included.

SAVINGS SUMMARY					
	Gas	**Water**	**Savings/yr**	**Implementation**	**Payback**
Identified Opportunity	**MMBtu**	**1000 gal**	**Total $**	**Cost $**	**(years)**
Tune Boilers to 3.5% O2	660	0	$6,300	$4,000	0.6
Repair Steam Traps	1,090	96	$11,800	$2,000	0.2
Reduce Steam Leaks 50%	6,380	552	$68,500	$40,000	0.6
Blowdown Heat Recovery	1,800	9	$17,400	$40,000	2.3
Recover Flash Steam	5,120	456	$55,200	$150,000	2.7
Preheat Combustion Air 10F	660	0	$6,300	$15,000	2.4
Insulate Pipes and Tanks	1,800	0	$17,200	$27,300	1.6
Total	17,510	1,113	$182,700	$278,300	1.5

Energy Efficiency Measures (EEM):

1. Tune Boilers to 3.5% O2.

Situation: All three identical boilers have feedwater economizers that are operating well. Unit #1 has an old oxygen trim control; however, the sensor has not been calibrated for many years and it is only used to display excess oxygen. Boilers are tuned twice a year, with little variation in settings. We obtained tuning reports from July 2008 and observed that Unit #2 was operating between 4 and 4.5% excess oxygen at mid-firing rates but was creating carbon monoxide (CO) at higher firing rates when O2 dropped below 4%. Unit #3, which was not operating during the ESA visit, was tuned to approximately 3.2% O2 at mid-firing rates with 0-4 ppm CO. We measured combustion gases for units #1 and #2 during the visit. Unit #1 was operating with 36 ppm CO at 4.8% O2 on the panel display and 5.8% on the combustion analyzer. Unit #2 was operating with CO alarm levels >500 ppm at 4% O2. We use at average 4.5% O2 level with stack temperature approximately 290ºF after the economizer.

Solution: We believe that the boilers can all operate properly with 3.5% excess O2 at medium and high fire and therefore recommend tuning the boilers from an average 4.5% excess O2 to 3.5%. SSAT calculates boiler efficiency will improve 0.3% from 83.5% to 83.8%. We estimate that control adjustments and minor hardware repairs that might be needed would cost approximately $4,000. Additional savings might be achieved by updating and using or adding oxygen trim controls.

Savings: SSAT calculated savings from Project 3 to be approximately $6,300/year with a 0.6-years payback.

2. Repair Steam Traps.
Situation: The company has infrared and ultrasonic equipment to identify and tag steam and trap leaks weekly. There are several leaking steam traps around the plant.

Solution: Plant personnel provided a list of 117 steam traps, of which 7 had failed, generally open. We used defaults in SSAT, which estimated that 10 traps would fail. Continue an excellent program to repair or replace leaking steam traps. We used project 11 in SSAT to reduce the number of leaking steam traps by 50%. We estimate an implementation cost of $2,000.

.
Savings: SSAT calculates savings to be $11,800/yr with a 0.2-year payback.

3. Reduce Steam Leaks 50%.
Situation: There are several steam leaks around the plant. Some are in valve packing seals; some are in pipe and fitting connections. Others are leaks in valves and piping that will need to be welded or replaced. Steam use on down days is approximately 7,000 lb/hr. We estimate that steam leaks account for approximately 15% or 1000 lb/hr of steam

Solution: We modeled 280 leaks in SSAT to achieve an estimated 1,000 lb/hr of steam leaks, which plant personnel thought was reasonable. Locate and repair steam leaks to reduce by 50%. We used project 12 in SSAT to reduce steam leaks to 140. We estimate the cost to be $40,000.

Savings: SSAT calculates savings to be $68,500/yr with a 0.6-year payback.

4. Blowdown Heat Recovery:
Situation: The plant uses a water softener to treat boiler make-up water. Mud (bottom) blowdown occurs once each shift. Top (continuous) blowdown occurs automatically based on a conductivity sensor for each boiler set to maintain 4600-4800 msiemens in the boiler. Blowdown water flow is metered at 3% of feedwater flow. The existing flash tank vents flash steam to the atmosphere and condensate to the drain.

Solution: Add a pressurized blowdown heat recovery tank to preheat the boiler make-up water and send the flash steam to the DA tank. The plant team estimates the implementation cost to be $40,000.

Savings: SSAT calculates savings from Projects 5 and 9 to be $17,400/yr with a 2.3-year payback.

5. Recover Condensate Flash Steam.
Situation: The boiler produces an annual average 17.9 klb/hr of steam. 2.5 klb/hr of steam go to the DA tank, blowdown, and steam leaks. Steam applications use 15.4 klb/hr. Trap losses account for 100 lb/hr and of the remaining 15.3 klb/hr of condensate, approximately 95% of the condensate is being returned to the boiler. The steam system currently has an atmospheric condensate return with insulated condensate lines and no flash steam heat recovery. Approximately 15% of the steam system energy is lost as flash steam. Plant is currently considering two projects to preheat candy ingredients from 120 to 180F before the steam cookers. Much of the plant steam use is in the kitchens so that the applications are near the source of flash steam.

Solution: Add a condensate tank with heat exchanger to the system in each kitchen to recover condensate flash steam to preheat ingredients. Plant staff estimates the cost to install flash steam recovery systems in both kitchens to be approximately $150,000.

Savings: SSAT calculates savings from Project 11 to use approximately 410 lb/hr (18% of the available 2.3 klb/hr) of flash steam for preheating ingredients. Savings of water and natural gas will be $55,200/year with a 2.7-year payback. Note: the plant team is considering applications to use more than 1.5 klb/hr of additional, available flash steam.

6. Preheat Comb Air 10ºF:

Situation: Combustion air is currently drawn from the front of the boiler between 80 and 90 ºF. We observed that the temperature was 20-30 ºF warmer near the top of the boilers.

Solution: Duct combustion air from the top of the boiler room to the boiler air inlet. The plant team further recommends a design so that the ductwork does not significantly impede access to the front of the boiler. We estimate that a temperature increase of 10 ºF is possible, but recommend proceeding with one unit to confirm. SSAT calculates boiler efficiency will improve 0.3% from 83.5% to 83.8%. Cost is estimated to be $15,000.

Savings: SSAT calculates savings from Project 3 to be $6,400/yr with a 2.3-year payback.

7. Insulate Steam and Condensate Piping.

Situation: The plant team measured the following average temperatures for un-insulated steam and condensate piping and fittings. The boilers were built in 1976. The shells had hot spots over 200F where insulation may have shifted or was missing and one of the ends had temperature over 200F. Installation costs were estimated from 2006 projects increased by 20%.

Insulation Summary							
	Temp	**Diameter**	**Length**	**Savings**	**Savings**	**Cost**	**Payback**
Application	**ºF**	**inches**	**feet**	**10^6Btu**	**$**	**$**	**years**
Steam Header 16"	345	16	15	404	$3,880	$1,858	0.5
Boiler Room Header fittings(5)	345	4	15	118	$1,133	$606	0.5
Steam Header 3"	345	3	20	123	$1,184	$662	0.6
Steam Header 2" Dot	345	2	35	149	$1,429	$1,084	0.8
Condensate Return 2" Dot	200	2	66	95	$910	$1,064	1.2
Boiler Shell #1	155	96	18.5	363	$3,482	$10,000	2.9
Boiler Shell #2	155	96	18.5	363	$3,482	$10,000	2.9
Boiler #1 End	170	96	1.8	91	$874	$1,000	1.1
Boiler #2 End	170	96	1.8	91	$874	$1,000	1.1
Total				1,800	$17,200	$27,300	1.6

Solution: Insulate steam piping with 3" jacketed mineral fiber pipe insulation and the condensate piping with 1 ½ " insulation. The boiler shell will need to be removed and replaced after new insulation is installed. Re-coat the inside of the boiler ends with insulating cement at the next scheduled maintenance. We used 3Eplus software to estimate savings for each component. The surfaces with the highest temperatures have the shortest paybacks, however any insulating of bare surfaces has a relatively short payback. Un-insulated valves and pipe fittings often have custom-fit blankets and wraps that are removable for maintenance and therefore have higher cost and longer payback than straight pipe.

Savings: 3Eplus calculates savings to be approximately $17,200/yr with an estimated total cost of $27,300 with a 1.6-year payback.

Operation and Maintenance Opportunities

Operation & Maintenance Opportunities
1. Replace incandescent lamps with compact fluorescent lamps. Even if they wander, they save energy wherever they are. An alternative is to replace alternate incandescent fixtures with T8 fluorescent fixtures.
2.

Management Support and Comments:
Plant has a corporate energy manager and a target to reduce energy use by as much as possible.

DOE Contact at Plant/Company: (whom DOE would contact for follow-up regarding progress in implementing ESA results.)

Jim Smentek
Director of Engineering and Maintenance
7401 S Cicero Ave
Chicago, IL 60629
Phone: 773-838-3550
FAX: 773-838-3403
Email: jsmentek@tootsie-roll.com

Disclaimer

The work described in this report is funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) Industrial Technologies Program. The primary objective of the Energy Savings Assessments (ESA) is to train plant personnel to use USDOE software tools to identify and evaluate Energy Efficiency Measures (EEM) that would reduce plant energy use and costs. Some EEMs may require additional engineering design and capital investment. When engineering services are not available in-house, we recommend that a consulting engineering firm be engaged to provide design assistance as needed. In addition, since the site visits by the USDOE energy experts are brief, they are necessarily limited in scope.

The energy expert believes this report to be a reasonably accurate representation of energy use and opportunities in this plant. However, because of the limited scope of the visit, the U.S. Department of Energy and the energy expert cannot guarantee the accuracy, completeness, or usefulness of the information contained in this report, nor assume any liability for damages resulting from the use of any information, equipment, method or process disclosed in this report.